Superconducting Undulator Program Goals

- Develop, fabricate and install an undulator tunable over the range of 21~28 KeV on first harmonic for Inelastic X-ray scattering studies (Alp)
- Achieve high field quality to achieve high intensity 3rd harmonic beams (Haeffner)
- Investigate the possibility of shorter period undulators, ~ 12 mm for future programs in applied materials research, geological studies, and bulk material studies

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Collaborations with Fermilab and UW-Madison Applied Superconductivity Center

15 mm Period Superconducting Magnet Parameters

Magnet bore ~ 8 mm

Coil cross section = 4.2 x 4.8 mm^2

Average current density $\approx$ 1000 A/ mm^2

$NI_{op} \approx$ 20 kA-turns, N $\approx$ 24 turns

Conductor: NbTi/Cu @4.2K or 1.9K

Comparison of Parameters for 8 mm Bore Superconducting and Permanent Magnet Undulators

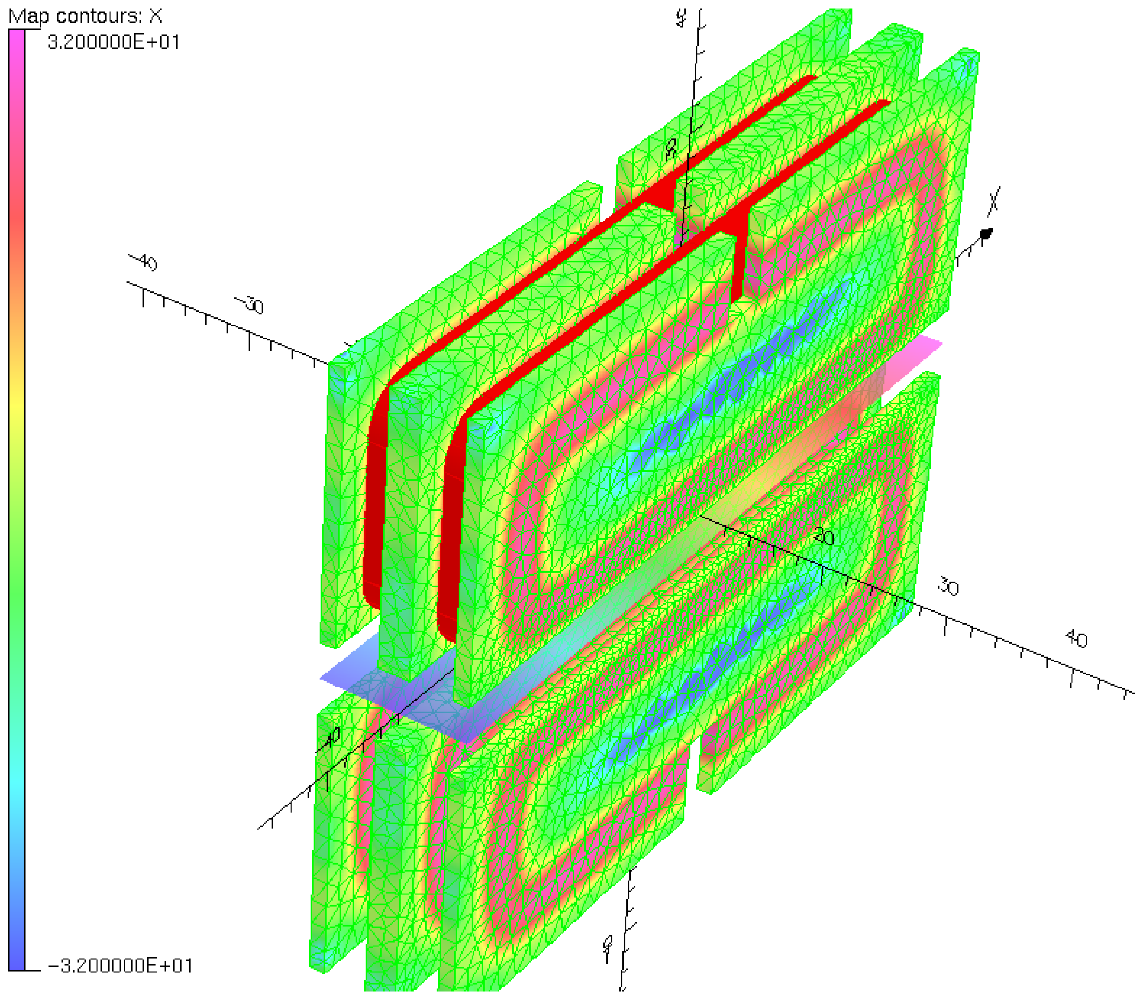
Superconducting Undulator:

λ(mm)	E_1 (keV)	$K=0.0934\ \lambda B_o$	B_o (T)
15	15.66	1.401	1.0
	19.06	1.121	0.80
	20.96	0.981	0.70
	28.52	0.42	0.30

Permanent Magnet Undulators:

15	27.6	0.5	0.365

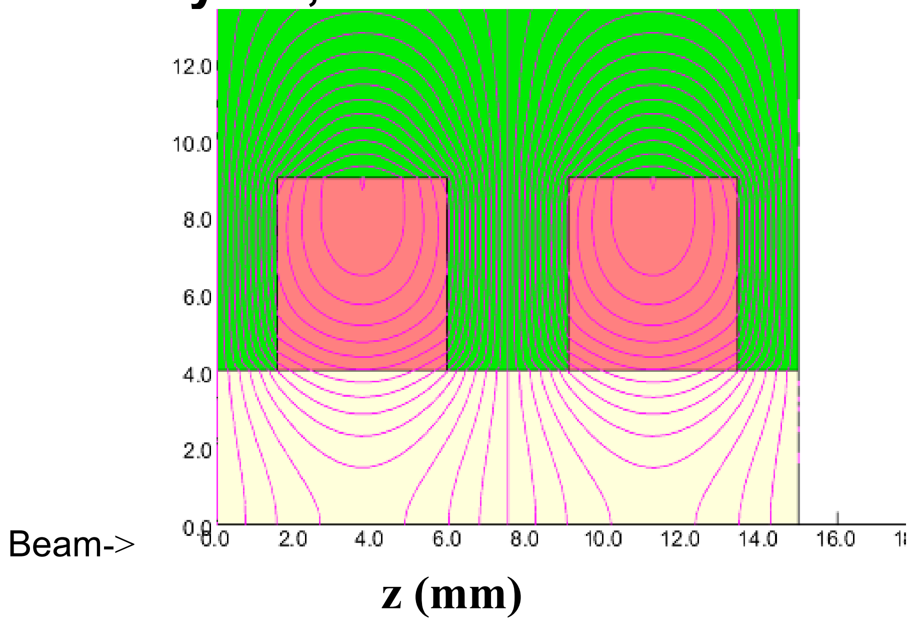
ADVANCED PHOTON SOURCE



Conceptual View of Superconducting Undulator

One Period

2-D for y > 0, x = 0 near the Beam Axis



<u>λ = 15 mm Superconducting Undulator</u>

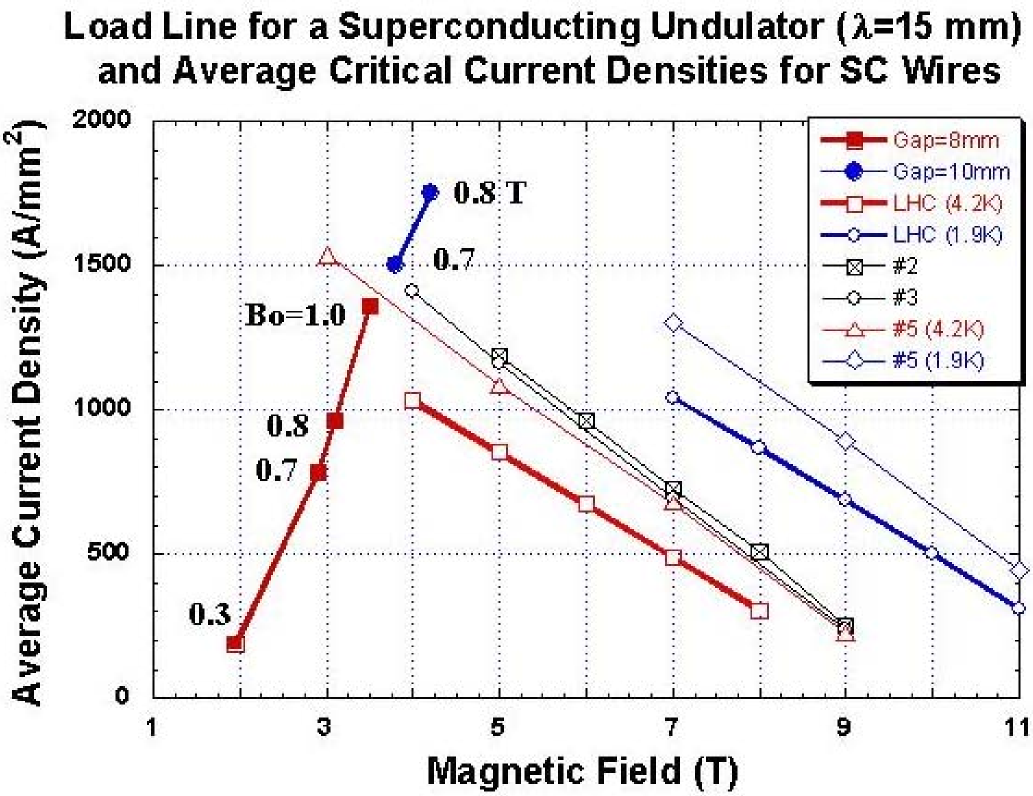
R&D Program in Support of Building a 15 mm Period, 8 mm Bore Superconducting Undulator

- Short Sample Tests of wires
- Small coil or bobbin tests
- Test of few period device in vertical dewar
- Studies on quench and coil protection
- Mechanical tolerances & field trimming
- Field measurement methods
- Design studies for beam chamber
- Heat load studies due to image currents and low energy synchrotron radiation

Present Status

- SC wires for R&D program are in house
- Preparing in house test facility. Existing vertical cryostat leak checked. Power supplies on order
- First short sample tests conducted at Fermilab
- Test bobbin for wire tests in shops
- Other activities not yet started, but are in planning stage

ADVANCED PHOTON SOURCE



1. Load line for full magnetic pole gap of 8 mm, average current calculated at B_o = 0.3, 0.7, 0.8 and 1.0 T.
2. Load line for gap of 10 mm, at 0.7 and 0.8 T.
3. Average critical current density for LHC conductor (dia = 0.89 mm) at 4.2K and 1.9K (CERN data).
4. #2: rectangular wire (1.05 x 0.77 mm), Ic (at 5T) = 960A at 4.2K.
5. #3: dia = 0.896 mm, Ic (at 4T) = 890A at 4.2K.
6. #5: dia = 0.753 mm, Ic (at 3T) = 684A at 4.2K.
7. #5: dia = 0.753 mm, Ic (at 7T) = 579A at 1.9K.
   (#2, #3, #5 wires measured at Fermi in 10/02. Above 6T the data are close to those provided by vendors.)
   LHC sire has low Ic density because Cu/SC = 2 (approx) compared to #2, #3, #5 wires with Cu/SC = 1.3 (approx).

Schedule for 15 mm Undulator

- Most of R&D program for support of construction performed in FY’03 (funding approved)
- Submit procurement in early FY’04 (subject to budget approval)
- Start installation in early FY’05
- Complete installation in first quarter FY’06 and start commission in FY’06

Beyond the Alp's, R&D Program for FY'04 & FY'05

- What is highest Jc?
- Develop field shimming techniques to achieve high intensity 3rd harmonic x-ray beams
- How small can the gap go to help achieve higher field at shorter period?
- Continue to see how far technology can be pushed, 12 mm, 1.9 T
- Can you build single turn, very high current undulator that will be conduction cooled?
- Can you eliminate the vacuum chamber and use beam liner?